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REASON VS. TRADITION IN THE TREATMENT
OF CERTAIN INJURIES TO THE WRIST-
JOINT.

BY L. S. PILCHER, M.D.

Compliments of


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INTRODUCTORY.



The role in life played by the hand, and the anatomical arrangements whereby it is fitted for its part, render the wrist-joint especially liable to suffer from violence.

Contusions, sprains, fractures and dislocations, in varying degree of severity and of combination, result.

Simple contusions, and the lighter sprains, producing but a trifling and temporary inconvenience, and compound dislocations and fractures, accompanied by such extensive disorganization of the parts as to demand in their treatment exsection of portions of bones, or amputation, are alike foreign to the scope of this inquiry.

Simple dislocations of the carpus upon the forearm, either backwards or forwards, but most frequently backwards, described by Hippocrates, were accepted as frequently occurring injuries by all surgeons until within the present century.

It was reserved for Dupuytren, in these latter days, to prove that these injuries were of exceeding great rarity. No case of the kind ever occurred in his experience. In all the literature of the subject from that time to this, during which inquiry has been stimulated by the positive assertions of the great French surgeon, only a half dozen incontestable cases have been recorded. (Vide Injuries which happen to the Wrist-joint, etc. Cruse. Transac. Med. Soc. State of N. Y., 1874.)

Practically, therefore, the dislocations of the carpus, though recognized as not absolutely impossible occurrences, may be omitted from an enumeration of the injuries to the wrist-joint whose treatment need be considered. Should such an injury take place, reduction of the dislocation having been effected, the injury would be resolved into a severe sprain, and as such, its treatment would be conducted in accordance with the principles hereafter to be set forth, in connection with the discussion of such injuries. Uncomplicated dislocation of the lower extremity of the radius, or of the ulna, from their articular connections, are to be placed in the same category with dislocations of the carpus. Both very rare, that of the radius extremely so,* their treatment, after reduction has been effected, would be essentially that of severe sprains. The injuries which remain for special consideration are :

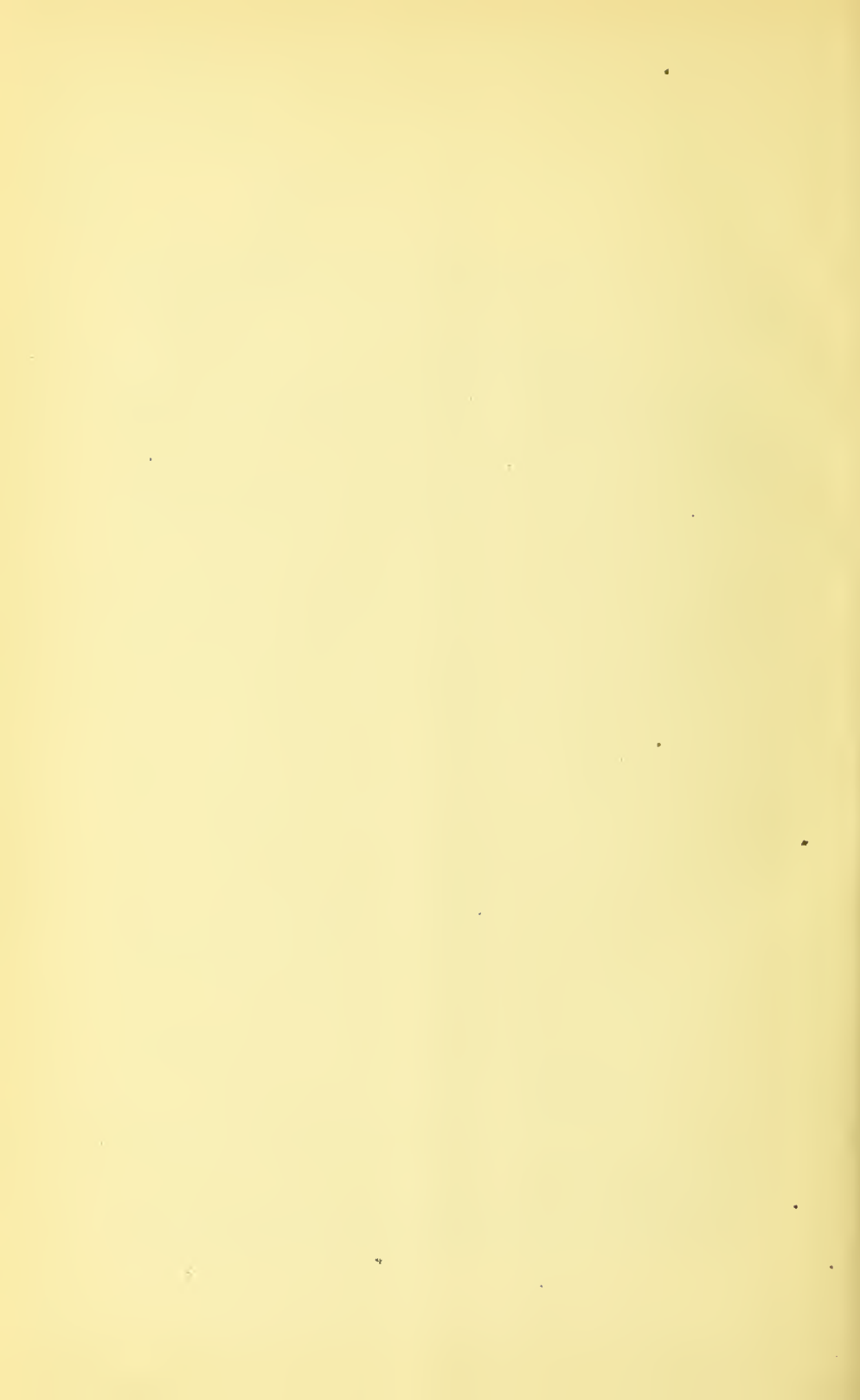
1. Severe sprains.
2. Fracture of the radius near the wrist-joint.
3. Fracture of the radius near the wrist-joint, with dislocation of the ulna, more or less complete.
4. Fracture of the radius and ulna near the wrist-joint.

*Desault claimed to have been the first to have discovered it, and substantiated his assertions by actual dissections.

Vide Cruse., op. cit., p. 74.

Sir Astley Cooper describes it as one of the dislocations occurring at the wrist-joint. Treatise on Dislocations and Fractures of the Joints. London: 7th ed., 1831, p. 376.

Hamilton makes no mention of it in his work on Fractures and Dislocations.



P A R T I .

SPRAINS.

Any injury sustained by the structures composing an articulation, from movements executed by it, either in an improper direction, or to an excess in a proper direction, without displacement of the corresponding articular surfaces from each other, must be classed as a sprain. In the lighter sprains, an overstretched ligament, with perhaps some of its fibres lacerated, may constitute the sum of the damage sustained. In the more severe sprains, contused articular cartilages, torn ligaments, overstretched tendons, bruised nerves, lacerated muscles, ruptured blood vessels and infiltrating blood, combine to produce an injury of the gravest importance.

Between these two extremes every grade of severity may be presented. From all alike, by neglect, improper treatment, or a peculiar constitutional vulnerability, disastrous consequences may result.

“They are the fruitful source of lameness; they lead to the destruction of joints; they may be the determining factor in malignant disease; they cut a ghastly figure in the causes for amputation.”*

Sprains are among the most common injuries which require surgical treatment.

The problem, How to treat them so as soonest to restore the healthy function of the joints implicated, and at the same time the most surely to prevent the development of unpleasant sequelæ, is one that has to be met by every practitioner.

On the principle that the greater includes the lesser, I shall limit my discussion to the consideration of the more severe sprains. I expect to be able to demonstrate that, in wrist-joint injuries, a wider range than has hitherto been accepted present sprain as the chief condition to be treated.

The special conditions presented by this joint are such as to render errors in treatment peculiarly liable to be followed by bad results. My views as to the indications for treatment of sprain at the wrist-joint, are based upon views entertained as to the rational treatment of sprain in

*The Pathology and Treatment of Sprains. Cowling: Louisville *Medical News*, May, 1877.

general, a somewhat full consideration of which I find to be necessary as the groundwork of future argument.

To this I invite attention.

The traditional treatment of sprain, consecrated by time and honored by the authority of the great names in surgery, has turned upon the one overshadowing condition feared—*inflammation*. Rest in the treatment has been, and is, recognized as, of all things, the most important. Whatever modifications of treatment have been adopted, absolute rest to the injured joint has continued to be accepted as the point of prime importance in the early stages of treatment.

The words of Gross* are: "Great care should always be taken in the acute stage not to move the parts too soon."

Erichsen† formulates the treatment of sprain in the words, "Rest, perfect immobility and compression."

"Keep the joint perfectly motionless," is the caution of Billroth.‡

To describe the results which may be expected in the case of severe sprains treated traditionally, I again use the words of Gross:§

"Convalescence will be tedious, and the joint may remain weak and tender for many months, if not for several years. * * * * * Sometimes, even when every possible precaution has been adopted, it will be found that the articulation not only continues to be weak and uncomfortable for a long time, but that the corresponding limb becomes cold, wasted, flabby and exquisitely sensitive; perhaps, also, the seat of neuralgic pain, subject to severe exacerbation whenever exercise is attempted or there is a change in the weather. Occasionally, indeed, the movements of the joint are never regained."

This opinion of Gross will be sustained by general surgical experience. After a severe sprain, with every care in the use of the means sanctioned by authority and tradition, tedious convalescence and prolonged weakness and tenderness of the joint is the rule; rapid or perfect recovery the exception.

A step forward in the treatment of sprain was made by the introduction into surgical practice of the "immovable apparatus," whether of starch, or plaster of Paris, or soluble glass, whereby the surgeon has been enabled to secure continued rest, perfect immobility, and equable compression of the joint, without restricting the general movements of the patient. In the use of this means the idea of immobilization has been more especially prominent. The value of the compression which it also may be made to exert has been an after-thought, which even yet has not been generally considered, nor its full therapeutic value appreciated.

*Gross—System of Surgery, Vol. II, page 26.

†Erichsen—Science and Art of Surgery, Philadelphia, 1873, Vol. I, page 297.

‡Billroth—Surgical Pathology, Translated by Hackley, 1871, page 215.

§Gross, op. cit., Vol. II, p. 24.

Compression to hasten the absorption of effusions is an old doctrine; but compression to prevent effusion, especially in its application to a recently-sprained joint, smacks of novelty. A most energetic advocate of this mode of treatment has been Mr. Sampson Gamgee, of England. I give his own words:*

“The swelling is great, the pain intense. The orthodox treatment, by leeches and fomentations, is valueless, compared with circular compression and perfect immobilization. * * * * Not only can the patient bear well-applied pressure *from the first*, however great the swelling and acute the pain, but it may be laid down as a general proposition, to which I have never seen an exception, that in severe sprains effusion is *most surely checked*, and, once it has occurred, its absorption is most rapidly promoted, while pain is most effectually relieved, by pressure and immobilization.”

Another doctrine, directly at variance with the time-honored traditions of rest and immobilization, has for some years been on trial. The words *compression, motion, use*, describe this doctrine.

In 1858 appeared a pamphlet by Dr. Peter Hood, of England, “On the Treatment of Sprained Ankle,” in which this method of treatment was advocated, supported by his own experience. After thirteen years, his son, Dr. Wharton P. Hood, makes the following record of the results of such treatment:†

“In cases of injury (to joints) we may resort to movement, either immediately or after the lapse of a few days. The *former* course has long been pursued by my father, Dr. Peter Hood, in the treatment of sprained ankle; and in his hands, and in the hands of others who have followed the practice, its effect has been simply preventive of nearly all the troubles that such an accident so often entails.”

Dr. Cowling, of Louisville, Ky., in the paper read before the Kentucky State Medical Society, on “The Pathology and Treatment of Sprains,” from which I have already quoted, records an instructive experience bearing upon this Hood doctrine. I quote:

“My attention has more than once been called to the fact that immobilization is not absolutely necessary from the first, even in cases of sprain apparently severe, and I have been caused to think much upon the means of discovering where the line was to be drawn. Two of my friends got a sprained ankle within a day or so of each other, and apparently very severe sprains. One submitted to my treatment, had a plaster boot, etc., and was all right in about a month. The other declined all restraint, rubbed his purple and swollen ankle, walked out heavily upon it, as he said, the day after his accident, and continued to walk in a very short time without inconvenience. He was a soldier, of vigorous build and indomitable pluck. He told me that the accident had frequently occurred to him during the war, and he had learned from experience that this was the best treatment for him. A man upon whom I had once put a paper boot for severe sprain told me afterwards that it was ‘next to the best way he ever saw of

* Gamgee—Treatment of Severe Sprains. *Lancet*, 1876, p. 629.

† W. P. Hood, “On Bone-setting,” 1871, p. 102.

treating sprained ankle; he had had it several times, and could walk it off, if he started in from the first.' * * * * A young lady had a sprain frightful to look at, extravasation extending from the instep up to the calf. It did not pain her much, she said. In spite of my lecture upon the danger of neglect, she took off the bandage and put on a shoe the next day after my visit, escaped confinement to do her spring shopping, and had no serious result—nay, no inconvenience! * * * * A few years ago, after a sleet, three cases presented themselves to me for injury at the elbow, resulting from falls. In all of these pain and voluntary immobility were prominent symptoms. In the careful examination and frequent movements necessary to diagnosis at this joint, while I discovered that the trouble was sprain, I saw also that the patients were more comfortable after I had done with them than when I had commenced."

No wonder that the thought that immobilization might not, after all, be indispensable, should have been suggested by such an experience. An appeal to the experience of every practitioner would, I am certain, elicit recollections of refractory patients, who would persist in disobeying the restrictive orders of their medical attendant, and yet recovered with remarkable rapidity from their sprains. I shall not add details of any other cases; they might be multiplied indefinitely. My own experience I will summarize. During the past five years I have had under treatment over one hundred cases of severe sprain, chiefly of the wrist, elbow, knee and ankle. In the treatment of every one, without exception, I have adopted the method which I have denominated the "Hood" treatment—viz., compression and mobilization—and in no case have I had reason to regret it. Those cases have improved the most slowly who would not follow the directions to move the joint fully and freely, but, from dread of hurting themselves, kept the parts at rest. In this mode of treatment, the bandaging necessary for accomplishing the compression is not only preventive of effusion, and resolvent in its action upon that which may already be present, but it also gives support to the damaged articulation, reinforcing the weakened, overstretched, lacerated ligaments; yet more, it gives protection against injury while recovery is taking place.

A yet wider divergence from the traditional treatment, with claims for still more rapid and satisfactory, even brilliant results, has been only very lately introduced by the advocates of massage. So wonderful was the success and so great the reputation obtained by Dr. Mezger, of Bonn, Germany, in the treatment, especially of joint affections, by the use of a combination of manipulations, such as rubbing, kneading, percussing and rolling of the soft parts, with passive movements, that his method of treatment, expressed by the term "massage," has attracted general attention. In this country, Dr. W. R. Fisher, in the *Medical Record* of January 1st, 1874, and Dr. Douglas Graham, in the *Philadelphia Medical and Surgical Reporter* of September 5th, 1874, first brought it to the attention of the medical profession.

Again, in the *Medical Record* of August 11th, 1877, Dr. Graham returns to the subject, with a *résumé* of three hundred and eight cases of joint contusions, or their sequelæ, treated by massage. I quote Dr. Graham's summary :*

"We have, then, the results of massage by seven independent observers, whose cases of joint contusions and distortions, sprains or their sequelæ, thus treated, amount in all to 308, of all grades of severity, of which the average length of time till recovery is 9.1 days. This time would be much less if the 39 cases were omitted in which massage was not begun until from ten days to three months had elapsed after the injury, 'in many of which,' says Berghman, 'other methods of treatment had failed,' and which required, on the average, about three weeks' massage till recovery. Of 55 cases treated by the usual method, the average length of time till recovery was $26\frac{1}{2}$ days, or nearly three times as long as similar cases required by massage. The advantages of massage, then, in such cases, would seem to be more speedy relief from pain and swelling, and earlier and more perfect use of the injured joints, than by any other method."

The details of the experience thus summarized, given in this report of Dr. Graham, are of exceeding interest, and will repay the most careful study. The following particular conclusions I find to be set forth by certain of the writers whose reports form the foundation of Dr. Graham's article :

1. The earlier after the injury massage is employed, the more speedy the recovery.—BERGHMAN.

2. Massage has an antiphlogistic and sedative effect, not an irritating one. It speedily obviates or removes blood-stasis, furthers the absorption and removal of accumulated parenchymatous exudation, as well as of the out-wandering white blood corpuscles, and thus restores the normal relations of pressure in the circulatory system.—BERGHMAN.

3. The previous application of an immovable dressing, even if but for a short time, diminishes the prospect of speedy cure by massage.—BERGHMAN.

4. The earliest possible use of the injured joints is very useful.—BERGHMAN.

5. The effects of massage are materially aided by making the patients use the injured limbs in spite of the pain.—GASSNER.

Finally, as to the value of massage in the treatment of sprains, I quote the sentiment of Dr. Rizet, which Dr. Graham has preserved to us in this same report. He says:

"Struck by the words of Baudens, at the Academy of Sciences, that 'of seventy-eight amputations of the leg, or of the foot, sixty had sprains for their origin,' it was with eagerness we seized opportunities to experiment with a means which, far from de-

* *Medical Record*, August 11th, 1877, p. 504.

ceiving us, has given unlooked-for success. They have strongly shaken the faith we had in the therapeutics preconceived by our predecessors and our masters, in forcing us to recognize that the application of immovable bandages in acute sprains has been the most powerful cause of the deplorable effects disclosed by the venerable surgeon of Val-de-Grace.’

Rest, immobilization ! Mobilization, use ! The Old and the New ! In support of the former, venerable tradition and great authorities; in support of the latter, few names, some recent experience. Placed in the crucible of clinical observation, the results given by the former are confessedly tedious, uncertain, often unsatisfactory, sometimes disastrous; by the latter, certainly no worse—they could not well be; on the contrary, if its advocates may be believed, rapid, reliable, complete.

But no medical fallacy, from the earliest times to the present, has prevailed, which has not been able to summon an ample clinical experience in its support—nothing so preposterous or incredible, the value of which has not been apparently clinically demonstrated, and in proof of which unlimited certificates may not be marshaled. Empiricism and rationalism in medicine must be mutually corrective, if true progress and reliable inductions are to be made.

A rational discussion, then, of the treatment of sprains, based upon a comprehensive appreciation of all the pathological conditions and processes presented in such an injury, is necessary to a true decision of the merits of different methods proposed. That method with which both empiricism and rationalism most completely square must be accepted by the scientific surgeon. No conclusion, however, can be considered as final; for the possibility will always exist either that we misinterpret what facts we have, or else that other facts exist not yet discovered by us—unknown factors, unexplored remainders, which, when they shall become known to us, will again modify our conclusions.

As bearing upon a conclusion as to the rational treatment of sprains, I submit the following theorems as principles of pathology and physiology, which need no demonstration at my hands; they are our common property—legacies received from Hunter and Paget and Simon :

Sprains are subcutaneous injuries.

In general, injuries which are subcutaneous seldom inflame.

The most obvious immediate result of a sprain is swelling of the part.

This is due partly to extravasation of blood, but usually much more to the rapid afflux of blood to and exudation of fluid from the vessels in the injured part.

This active congestion, upon its subsidence, leaves the blood vessels of the part dilated, and the blood stream more sluggish than natural for a time. If this condition is prolonged and intensified until complete stagnation of the blood current is produced, the initial condition of inflammation is supplied.

The exudation consists chiefly of serum; mingled with it is a small proportion of

coagulable lymph. If inflammation be developed, the proportion of coagulable lymph in the exudate is greatly increased.

The continuance of this exudative process is limited to the first two or three days after the reception of the injury, unless inflammation supervene.

After that time, absorption of the effused fluids, more or less rapid, takes place, with complete repair of the injured tissues in due time.

The coagulable lymph suspended in the serous effusion may remain for some time fluid, and in this state may be readily re-absorbed.

By its coagulation the tissues are rendered indurated and adherent.

The damage sustained by an injured part will be in direct proportion to the length of time during which the exudation within its tissues remains unabsorbed, and opportunity is afforded for the coagulation of its contained lymph.

Absorption is hindered and effusion promoted by languor of the circulation.

Absorption is promoted by acceleration of the circulation, by diffusion of the effused fluids and by continuous pressure.

The processes of repair, including absorption of superfluous exudation, will be most active in a part which approaches nearest a condition of perfect health.

A due performance of its natural function by a part is necessary to keep it in a state of health. A prolonged suspension of its natural function will, of itself, induce disease in its structure.

An injury sustained by a part may demand temporary suspension of its function, partial or complete.

This suspension is itself an evil, and should be abandoned as soon as the use of the part to any degree will no longer prolong or aggravate the consequences of the injury.

The normal function of a joint is motion—this involves friction, pressure and stretching, to a greater or less degree, of its constituent elements.

If inflammation of peri or intra articular tissues occurs, the adhesions resulting from the organization of the inflammatory exudate will, to a greater or less degree, prevent the performance of the function of the joint involved.

Inflammatory adhesions are more easily broken up in the early stages of their formation, when soft, than later, when they have become firm and well-organized.

That adhesions should be ruptured demands full and free separation of the parts adherent. Movements to the fullest possible extent permitted by the parts are needed for the accomplishment of such an end.

A single full and free movement will accomplish fully the rupture of forming adhesions. Repeated movements are unnecessary until fresh adhesions shall have formed.

The danger of increase of the inflammation by the performance of occasional full and free movements of the parts involved is not great. It may be reduced to a minimum by proper attention during the intervals of rest.

The practical conclusions which I deduce from the principles thus set forth, are as follows:

The swelling and congestion consequent upon a sprain by no means necessarily involves the presence of inflammation.

Active hyperæmia, primary, and passive hyperæmia, secondary, constitute the essential pathological conditions present. The more intense the former, the more prolonged the latter

The first is of short duration, not longer than three days; the duration of the latter is variable; it may be affected much by treatment; it may terminate in inflammation, in the development of which it is a most important factor.

There is no reason inherent in the nature of a sprain why the general law that *subcutaneous injuries seldom inflame* should not apply to it.

That this law should be true of any injury demands, however, two things:

1. That it be protected from further injury.
2. That it be placed in a proper condition for recovery from the injury already sustained.

The fulfillment of these two indications for treatment demands different measures in the differing pathological conditions present at different times in the course of a sprain.

The mode of treatment characterized as that of *absolute rest and immobilization* answers admirably the indications presented during the stage of active hyperæmia. It protects from further injury, lessens the amount of blood deterioration and of exudation, and diminishes the proportion of coagulable lymph in the exudation. If prolonged beyond this first stage, while it still answers the first indication, to protect from further injury, it favors languor of the circulation, thus hindering absorption, and increasing the danger of the formation of adhesions between adjacent parts; it promotes firm organization of adhesions once formed, and contributes to degenerative changes in parts by suspension of their function. The more severe the original injury, the more intense the active hyperæmia immediately resulting, and the more serious the tendency to passive hyperæmia, its sequel. Complete disuse and absolute immobilization tends to prolong this state, and thus to increase the danger of inflammation.

The inflammation thus lighted up would be necessarily sub-acute and chronic in its character, the very result which tradition has taught us as inevitable in some cases, despite the most careful treatment.

The equal and constant pressure which the immovable apparatus may be made to exert upon the part to which it is applied is of great value in promoting absorption of exudates. It is the chief element of value which this application possesses in the treatment of the second stage of a sprain.

Mobilization and use—as typified in the processes of massage, brushing aside the first indication, viz., protection from further injury, as of comparatively little moment—afford, most admirably, the conditions favorable for recovery from the results of the injury sustained, after the subsidence of the primary active congestion. Dilated blood vessels are stimulated to contraction, the languid circulation is accelerated, ab-

sorption of effusions is promoted, adhesions are prevented, repair is rendered active, a speedy restoration of the natural function of the joint is made probable.

The appeal to reason sustains the claim to superiority which has been made for mobilization and use over rest and immobilization more particularly in the treatment of the second stage of sprains.

It has appeared, also, that this second stage is the one upon the proper treatment of which depends, in greatest measure, the result of the case. It is reasonable, therefore, to expect that the mode of treatment which most fully meets the indications of this stage will accomplish the best results in general.

The caution which Reason gives is, not that care should be taken not to move the parts too soon, but that care should be taken not to delay moving the parts too long !

Nevertheless, the rational surgeon will not neglect the indications presented during the first stage, short as it is. The rapid afflux of blood is to be checked; the blood vessels are to be stimulated to contraction; bruised and torn nerves are to be soothed; overstretched or lacerated ligaments are to be reinforced; effusion is to be limited and pain is to be relieved.

Rest, hot water and the bandage fulfill these indications.

In the treatment of the second stage of sprain, the advantage to be derived from the compression and support afforded by a properly applied bandage may be secured in connection with the manipulations of massage, and may go far to supplement the deficiencies of the individual surgeon as a practical masseur.

It has been impossible for me to abbreviate this somewhat extended discussion of the general subject of sprains. In none of the standard surgical treatises that I have been able to consult has an attempt been made to discuss these injuries to the extent which their frequency and importance would justify, while in some of the more recent and pretentious publications they are not even so much as mentioned. The treatment of certain injuries in the neighborhood of the wrist-joint, yet to be considered, which I shall advocate, is based upon the principles which I have now presented. I could not expect assent to methods of treatment in particular cases without having demonstrated the principles upon which those methods were based.

The anatomical conformation of the wrist-joint is such, that an injury sustained by it, improperly treated, is especially likely to inflict irreparable damage. The tying together of the bones of the forearm by the inferior radio-ulnar ligaments, and by the triangular fibro-cartilage, and the attachment of the carpus by means of the anterior and posterior and lateral ligaments, presents nothing remarkable. But of equal importance

with these, in giving strength to the joint and sharing in all its vicissitudes, is the mass of flexor tendons covering it in front, ensheathed in two extensive synovial sacs, and the extensor tendons spread out over it behind, running through six separate synovial investments.

The extent and freedom of its movements, and the character of its functions, expose it constantly to danger of injury.

Into the numerous superficial, extensive and delicate synovial sheaths which surround the joint, copious effusion rapidly follows an injury received; the tendons are bathed in it; extensive adhesions are possible; should inflammation be excited, a firm matting together of all the tissues results, with serious crippling of the joint.

Here are conditions which demand active and skillful treatment. Here are tissues so situated, that needed applications may be made with certainty and directness to the parts affected. Here the most important indication is clear—adhesions must be prevented.

The most important element in the treatment I conceive to be *motion*, not restricted, not tentative, not necessarily frequent, but full, decided and at regular intervals, just as a medicine might be administered for an internal disease.

Next, *massage*. No joint in the body affords more favorable conditions for securing the full value of this process.

Next, *support* and *compression*, by the application of a bandage encircling the joint. A strip of adhesive plaster, about two inches in width, answers best for this purpose.

Rarely will it be necessary to have recourse to absolute rest and fomentations during the first two or three days following an injury; never after that time.

PART II.

FRACTURES.

1. Fracture of the radius near the wrist-joint
2. Fracture of the radius near the wrist-joint, with dislocation of the ulna.
3. Fracture of the radius and ulna near the wrist-joint.

Fracture of the radius within an inch of the wrist-joint is of frequent occurrence.

The literature of this fracture is extensive. A subject of controversy from the time of its first accurate description by Colles, in 1814, the frequency of its occurrence and the difficulties attending its satisfactory treatment have been such, that it has engaged the attention of many of the ablest surgical minds of each generation since.*

The following is the description given by Hamilton† of the results obtained in the treatment of this injury:

“Eighty examples of fracture of the lower third of the radius furnished no cases of non-union, nor, indeed, do I remember ever to have seen the union delayed; yet only eighteen are positively known to have left no perceptible deformity or stiffness about the joint; it is probable, however, that the number of perfect results might be somewhat extended. * * * * Twice I have found the wrist and finger-joints quite stiff

*For résumé of the literature of this fracture, see the Essay on Wrist-joint Injuries, etc., T. K. Cruse, M.D., Transac. Med. Soc. State of N. Y., 1874, heretofore referred to.

†Hamilton, F. H. Fractures and Dislocations, 1866, pp. 278 and 279.

after the lapse of one year; in one case I have found the same condition after two years; in one case after three years, and in two cases after five years. * * * * *

There remains, for a long time, in a majority of cases, a broad, firm, uniform swelling on the palmar surface of the forearm, commencing near the upper margin of the annular ligament, and extending upward two inches or more. This swelling continues much longer in old and feeble persons than in the young and vigorous. It is pretty generally proportioned to the amount of ankylosis existing at the wrist and finger-joints, and it disappears usually *pari passu* with these conditions. There can be no doubt that this phenomenon is due to an effusion, first serous, and subsequently fibrinous, along the sheaths of the tendons; and it is as often present after sprains and other severe injuries about this part, as in fractures. In many cases, however, its prolonged continuance and its firmness have led to a suspicion that the bones were displaced—a suspicion which only a moderate degree of care in the examination ought easily to dispel. A similar effusion, but less in amount, is frequently seen also on the back of the hand, below the annular ligament. When both exist simultaneously, the appearances of deformity and displacement are greatly increased. Here, then, we shall find a partial explanation of the ankylosis in the wrist and finger-joints, which continues occasionally many months, or even years, if, indeed, it is not permanent—an ankylosis produced, in a few instances, by extension of the inflammation to these joints, but much more often by the inflammatory effusion, and consequent adhesions, along the thecal and serous sheaths, through which the tendons all pass in their course to the hands and fingers, and by simple contraction of the articular ligaments as a consequence of disuse.

* * * I have seen the fingers rigid after many months, when, having observed the case throughout myself, I was certain that no inflammatory action had ever reached them. * * * * *

To what I have said as to the prognosis in these accidents, I may be permitted to add the opinion of our distinguished countryman, Dr. Mott, given in a clinical lecture before his class in the University of New York: ‘Fractures of the radius, within two inches of the wrist, when treated by the most eminent surgeons, are of very difficult management so as to avoid all deformity; indeed, more or less deformity may occur under the treatment of the most eminent surgeons, and more or less imperfection in the motion of the wrist or radius is very apt to follow for a longer or shorter time. Even when the fracture is well cured, an anterior prominence at the wrist, or near it, will sometimes result from swelling of the soft parts.’ ”

This long quotation from this recognized authority is suggestive. I shall have occasion to refer to it again—at this point I have introduced it because of the manner in which it depicts the results of treatment as directed by even eminent surgeons.

In the determination of the methods of treatment demanded by this injury, the reasoning has been simple and apparently conclusive.

The syllogistic formula runs thus:

Fractured bones need splints;

Here is a fractured bone;

Ergo, here splints are necessary !

With the demonstration of the existence of a fracture, that was at once assumed to be the all-important condition toward which treatment should be directed.

Colles taught that splints should be applied which should confine

the whole hand and forearm—a mode of treatment still practiced by some surgeons.

Many modifications have been advocated by divers surgeons, intended to meet supposed conditions present. In turn they have been discarded and forgotten, while at frequent intervals still descriptions of new modifications continue to find a place in medical journals. The vain attempt has been to devise some form of splint which, by its peculiar pressure upon or confinement of the parts, should ensure the retention of the bony fragments in perfect coaptation, and thus obviate deformity and lameness.

This constant effort to devise a new and more perfect form of splint implies a confession of previous failure.

The statements of results of treatment contained in the quotation from Hamilton is but a record of imperfect results.

Despite the fact that eager and able investigators have repeatedly searched the facts connected with this injury through and through, with almost microscopic minuteness, the difficulties surrounding the treatment of some cases have remained such as to call for the most guarded prognosis as to the results of treatment.

For this reason, therefore, I have endeavored to examine anew all the facts connected with this injury, and to critically question the meaning and relations of all the phenomena discovered.

To the methods of examination and the results achieved I now invite attention.

Fracture of the radius near the wrist-joint results almost invariably from falls, the force of which is received upon the palm of the hand.

The theory usually adduced in explanation of the injury resulting is, that the radius, being caught between two counter-forces, gives way at its weakest point, about one-half inch from its lower extremity.

An examination of the facts of the case does not sustain this theory.

In the first place, the force of the impact is, in great measure, broken before it reaches the radius.

The proof of this will appear in the examination of the mechanism of the wrist-joint, and the relations of its elements to the forces which determine the injury.

In the second place, the lower end of the radius, by its expansion, and by the number and direction of the bony lamellæ which constitute its mass, is specially fitted for receiving and breaking shock, when applied to its extremity, in the direction of the long axis of the bone. In this respect it is the strongest part of the bone.

The first effect, in order of time, of a fall upon the palm of the hand, is forced extension of the hand.

This movement is performed mainly at the carpo-radial articulation,

Here I present a longitudinal section through the wrist-joint, from the middle of the radius to the middle of the third metacarpal bone. (See diagram 1.) The section passes through the inner portion of the scaphoid and the outer portion of the os magnum.

The carpal bones and the metacarpal are joined together with such firmness that but slight motion is permitted between them.

In the movements of extension and flexion at the wrist they act virtually as one bone.

At the lower extremity of the radius projects anteriorly a prominent lip, into which is inserted the anterior radio-carpal ligament, the extent of insertion of whose fibres is continued for a quarter inch or more above the articular margin. This ligament, though dense and strong, is sufficiently loose to permit considerable latitude of motion backwards.

The posterior radio-carpal ligament unites the bones together behind similarly.

The bones, thus related, constitute two levers. They may be represented as in the accompanying diagram, by A and B, held together by bands at C and D.

When B is forcibly carried backwards (extension of the hand), the band, D, is made tense; the opposite border of the lever, having slipped forward as far



DIAGRAM NO. 1.

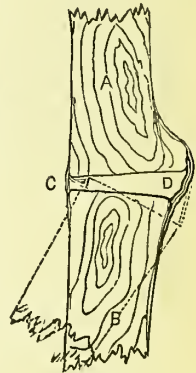


DIAGRAM NO. 2.

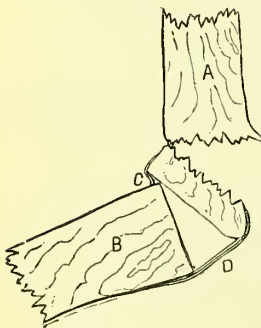


DIAGRAM NO. 3.

as the band, C, will permit, now abuts against the lower surface of A, which becomes a fulcrum for the further action of the lever. The mechanical arrangement is such, that an immense power may be exerted. If the backward force continues to act, either the band, D, must rupture, or a lever be fractured. The projecting lip upon the upper lever puts it at a disadvantage. The band continues to sustain the strain. The lever gives way. (See diagram 3.) The point of fracture is necessarily just above that portion of the lever controlled by the band. The strain

upon the lever is nearly transverse to its long axis. By this the direction of the line of fracture is determined. A fracture has been produced by definite forces, at a definite point, and in a definite direction.

This is the exact condition which is present in the production of Colles' fracture.

By the powerful leverage which the extended hand and carpus obtain through the strong anterior ligament upon the lower end of the radius, that portion of the bone is literally torn from it. The very arrangement of the expanded end, with its cancellated structure, which so admirably fits this portion of the bone for receiving and breaking shock, render it the less able to resist a force of avulsion. The combination of conditions is such as to make the bone weaker than the ligament, and the fracture of the bone accordingly takes place.

The truth of this is easily tested experimentally.

I take this forearm and hand, removed from the cadaver; the forearm being firmly held upon the table, I bend the hand backward strongly, until, with a sharp snap, some structure gives way. I dissect it before you. The anterior ligament of the wrist is intact, but about half an inch from the lower border of the radius a fracture is seen to have occurred, nearly transverse in its direction both from side to side and from before backwards.

The force used, whereby this injury was produced, was suspended the moment the fracture was produced. In this respect there is a correspondence with a large number of wrist-joint injuries in which the violence has expended itself when this point is reached.

When the bones are covered by the soft tissues, there is no perceptible evidence of a fracture having taken place. There is no displacement of the fragments. Posteriorly they are held together by the periosteum, which there is still intact. Their inequalities fit into each other, so that in rotation of the wrist they move together. No crepitus would be elicited by any ordinary movement. The symptoms presented would be those simply of sprain, with this addition, that pressure applied at the anterior outer aspect of the styloid process of the radius, one-half or three-quarters of an inch above its extremity, being over the line of fissure, would be especially painful. The conclusion is reasonable, that many sprains of the wrist are sustained and recovered from, in which a cracked radius has been an unsuspected accompaniment.

In that condition in which Colles' fracture is ordinarily recognized as being present, a second force other than that of extension is present, as an important and independent factor in the production of the results, viz.: the forward and downward impulse of the lower end of the radius, a force compounded of the weight of the body and the velocity of the

fall which has been sustained. At first this is received upon the anterior ligament and converted by it into a force of avulsion. If it be entirely expended here, sprain, or sprain with transverse fissure of the radius, results.

It is evident that at all times the force of the direct impact ultimately sustained by the radius will be greatly diminished, as the result of the actions now described. When it is not entirely expended, varying results follow, according to the degree of force yet in action.

If I take, again, the forearm and hand, the subject of the previous experiment, and place the palm of the hand upon the table, so that the wrist is strongly extended when the forearm is raised perpendicularly to the table, I imitate the position in which the parts are at the moment of the rending of the bone.

An impetus from above, communicated to the upper fragment, is alone needed to complete the imitation of the forces concerned in the production of the more severe forms of the injury.

I supply this by striking a blow with a mallet smartly upon the upper end of the humerus, which has been sawn across at its middle and still remains articulated with the bones of the forearm.

It is true that in the ordinary production of this injury no appreciable interval elapses between the coming into play of the various forces which this analysis describes and these experiments imitate. This distinct sequence, nevertheless, exists. The prolongation of the intervals in the experiment does not invalidate its accuracy as an illustration of the principles involved.

In experimenting upon the cadaver, the tonicity of the soft parts, present in life, is absent; a greater relaxation of an articulation is present, and an unnatural stretching of ligaments will occur before rupture takes place.

In the particular experiment in question, much power is lost, as the result of this, and the force of avulsion diminished. That, notwithstanding this, the result of the test should be that almost invariably the lower end of the bone is torn off, and the ligament remains intact, renders the demonstration of the method of causation of this fracture the more conclusive.

It is more difficult to experimentally produce the lesions which post-mortem examinations show, as well as examinations of recent injuries indicate, to have been sustained by the articular relations of the ulna in some cases, in consequence of this lack of tone, and resulting relaxation of the ligaments which bind it in its place.

The problem as to the character and order of the lesions which follow from the added force in question, is not difficult of solution: the force,

its direction and power, the strength and mechanical relations of the parts upon which it is expended, are the factors to be considered.

The specimen which I now show you, the result of the last experiment, illustrates the conditions presented by the radial fragments in the more severe forms of this injury.

A new point of motion has been established.

The lower fragment of the radius is now virtually a part of the carpus, with which it moves, and by which it is carried backwards. At its inner border it is still tied to the ulna by the triangular fibro-cartilage and by the radio-ulnar ligaments; at its outer border, being less restrained, the fragment has been displaced to a greater extent than at its inner, as the result of which a decided inclination to the radial side has been impressed upon the entire hand and wrist. The upper fragment, driven downward and forward, has become entangled in the lower near its palmar margin. The impaction is but slight, and disentanglement is easy when the attempts are properly made. The lower fragment is a broad thin shell of bone. If the upper fragment is driven into it with much force, its comminution is inevitable. That this sometimes occurs post-mortem examinations have repeatedly demonstrated.

Examination of the periosteum covering the back of the lower portion of the radius, shows it a very thick and strong membrane. It is reinforced by fibres prolonged from the posterior ligament of the wrist, and from the posterior annular ligament, by blending with which the canals are formed for the passage of the extensor tendons of the wrist and hand. By this blending of membrane, ligament and fascia, the posterior envelope of the radius at this point is converted into a thick, dense and strong aponeurosis, which, in the backward movement of the lower fragment in the production of the injury under consideration, is not torn through, but is simply stripped up from the back of the upper fragment, to a greater or less extent, according to the amount of displacement of the lower fragment.

Such you see to have been the result in the wrist, which is now the subject of experiment.

Such has been invariably the result in every experiment which I have made—a

half dozen of the preparations saved from which I herewith present for examination. The relation of the parts has now become such as is illustrated by diagram 4, in which this adventitious periosteal ligament is represented.

The recognition of this strong aponeurotic band firmly grasping the

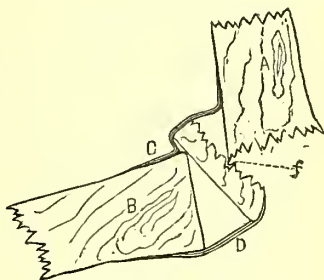


DIAGRAM No. 4.

lower fragment I conceive to be of the greatest importance; for, if I reason correctly, and do not misinterpret the results of my experiments, it is the key which unlocks the chief difficulties that surround this injury.

Here is the explanation of the immobility and absence of crepitus remarked as characteristic of this injury by all surgeons.

Here is the occasion of that tendency to immediate return of the deformity upon suspending extension, remarked by Colles; and the reason for the powerful extension necessary for reduction, and the great difficulty in retention, mentioned by Astley Cooper.

The theory of penetration of Voillemier, and the impaction described by Callender; the deformity from muscular action championed by Robert Smith, and the power of an ulnar styloid process, entangled in the annular ligament, described by Moore, may all alike be explained, and the phenomena ascribed to these different sources be reproduced, by the agency of this untorn periosteal aponeurosis simply.

In any given case the full series of events, as described, having been completed, the force having expended itself, and the injured member

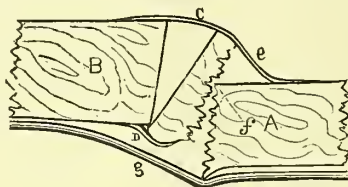


DIAGRAM No. 5.—*c*. Dorsal periosteal pseudo-ligament. *f*. Point of entanglement. *g*. Flexor tendons.

relieved from the weight upon it, entirely new forces begin to act upon it. The hand, recovering from the condition of forced extension, as it straightens, or becomes flexed, to the extent of its weight, tends to bring back with it the lower fragment of the radius. This fragment, abutting against the projecting posterior margin of the upper fragment (see *f*, diagram 4), is supported upon it as a fulcrum, and the result of the weight of the hand is simply to make still more tense the aponeurosis which is attached to it behind, already made tense in the original injury.

Meanwhile the mass of flexor tendons, covering the palmar aspect of the radius, are being pressed upon, stretched, sometimes lacerated, by the projection anteriorly of the lower end of the upper fragment. Their strong and continuous contraction simply aggravates the condition just described. The dorsal aponeurosis, unyielding, is kept tense; the entanglement of the irregular surfaces of the apposed fragments is increased; thus the characteristic deformity is produced and maintained, while immobility of the fragments and absence of crepitus is secured. The condition now is as represented in diagram 5. If strong extension is

made simply, upon its suspension the dorsal aponeurosis still remains efficient to cause the deformity to recur, without the intervention of any muscular action whatever. Powerful extension and strong direct pressure will be needed to force the lower fragment into its place. If the backward projection is allowed to remain to any degree, the vacant subperiosteal angle left will, in time, be filled in with new bone, which will enclose the compact lamina of the lower end of the upper fragment to the point where its periosteum had been stripped from it. Should a section of this be made after the lapse of years, an appearance of impaction or penetration would be presented well calculated to deceive.

Fracture and displacement of the lower end of the radius necessarily involves, to some degree, the ulna, to which it is closely united. The greater the radial displacement, the greater the strain upon its ulnar attachments, and also upon the attachments of the ulna and carpus.

When the radius has given way, and the force of extension is no longer arrested by the insertion of the anterior ligament into its broad margin, this force is felt strongly by that portion of the ligament which is inserted into the ulna; the whole hand, with the lower radial fragment, is caused to move backward and outward, as in supination; the styloid process of the ulna becomes approximated to the radius upon the back of the wrist, while the rounded head of the ulna is brought to project strongly upon the front and inside of the wrist. In this position the parts are firmly held; all rotation in either direction being prevented, as long as the backward displacement of the lower radial fragment remains unreduced.

The exact cause of this movement and this locking I have made a subject of frequent experiment. It occurs in experiments on the dead body equally as well marked as in the living body; it is, therefore, not the result of muscular action. Removing integument, annular ligament and superjacent tendons, no change results; entanglement of the styloid process in the annular ligament, therefore, is not necessary for its production. If the greater part of the anterior carpo-ulnar fibres are cut away, no relaxation results. If the triangular fibro-cartilage be now exposed, though this be without tension and thoroughly relaxed, the ulna and wrist are still firmly bound in their new relations to each other.

The real cause of these phenomena now appears:

From the front of the cuneiform bone, passing obliquely upwards and inwards (to the ulnar side), to be inserted into the anterior border of the styloid process of the ulna for half an inch or more, from the tip of the process upwards, is a strong fasciculus, the strongest part of this portion of the anterior ligament. Repeated experiment has uniformly demonstrated that this fasciculus is the part upon which first the chief strain falls after the radius has given way. The obliquity of its direction,

and the extent and place of its insertion, determine the movements which the movable parts attached to it shall make. By the backward displacement of the carpus and the attached radial fragment, this fasciculus is put upon the stretch, so that it becomes a strong, tense cord, limiting all rotation until relaxed. The action of this oblique inner fasciculus of the anterior ligament I show you in the specimens under examination.

As the result of this rotation of the hand and wrist upon the ulna, the tendon of the extensor carpi ulnaris, which ordinarily is found running along the inner side of the wrist, is now found upon its back, in close proximity to the inner border of the radius. To the casual glance it looks as if it had been dislocated from its proper groove and carried over to a new location; closer scrutiny shows that it is still in its proper sheath, and in its proper relations to the ulna—no displacement has occurred; and when, by the requisite manipulations, the radial displacement has been corrected, and the forced supination of the wrist is relaxed, this tendon again appears in its wonted place upon the inside of the wrist.

This completes the description of the peculiar lesions presented by fracture of the radius near the wrist-joint.

The important relations which the untorn aponeurotic dorsal periosteal strip and the inner oblique fasciculus of the anterior ligament sustain to the peculiar symptoms presented by this injury, have not hitherto been recognized.

The phenomena, of which these are the efficient agents, have been attributed to divers causes.

The importance of this demonstration cannot be exaggerated. The recognition of the relations of these structures renders simple the problem, heretofore esteemed difficult, as to the reduction and retention of the broken fragments.

Their demonstration appropriately introduces a discussion of the rational treatment of Colles' fracture.

TREATMENT.

The rational treatment of Colles' fracture must be such as will to the fullest extent possible answer the indications presented both by the bone injuries and by those suffered by the articular structures of the wrist.

Reviewing the steps in the genesis of this injury, it appears that the first step is a violent strain inflicted upon the anterior ligament by forced extension; that immediately consequent upon the yielding of the bone, a similar strain is thrown upon the ligaments which bind the ulna both to the radius and to the carpus. These are stretched, partially lacerated, sometimes entirely ruptured. The synovial sacs of the articulation are

badly contused. In some cases the line of fracture is such as to open into the inferior radio-ulnar articular cavity, producing laceration of its synovial sac and hemorrhage into it. In those severe cases in which comminution of the lower fragment has occurred, or more or less complete dislocation of the ulna, laceration of the synovial sac and hemorrhage into its cavity are important and inevitable complications.

By the displacement of the fragments, as described, the fibrous sheaths and synovial envelopes both of the flexor tendons in front, and of the extensor tendons behind, are injured. In front, the projection of the ragged edge of the upper fragment into the midst of the flexor tendons affords a fruitful source of injury to them; behind, the violent stripping up and continued tension of the periosteum is an injury done to the floor of all the tendon-sheaths, into the formation of which it directly enters. The fracture of the bone is thus both preceded and followed by a severe sprain to the joint. The sum of the injuries inflicted presents a sprain of the most aggravated description.

Is it possible to harmonize the treatment which the sprain demands with that called for by the broken bone? If not, which should have the preference—the sprain or the fracture?

The rational treatment of sprain of the wrist has already been fully discussed. It was then stated that of wrist-joint injuries a wider range than had hitherto been accepted would be found to present sprain as the chief condition to be treated. Thus far it has been demonstrated that in all cases of fracture of the radius near the wrist-joint sprain exists as an important condition to be recognized. To decide upon its relative importance in determining the treatment to be adopted, requires next a consideration of the fracture.

Fractures at the lower end of the radius may be divided into two distinct classes, viz.: those without displacement, and those with displacement of the fragments. This distinction is clear and important.

The first class is likely to pass unrecognized—to be called a sprain, and to be treated as such. Immediately upon the recovery of the hand from the over-extension which it had sustained, the corresponding surfaces of the fragments fall together where they are held by the weight of the hand as it is held prone. Upon the dorsum they are firmly joined to each other by the untorn periosteum. The line of fracture is transverse, and the apposed surfaces are broad, so that there is no tendency to displacement; force from without is necessary to make displacement possible. The conditions of the parts are favorable to rapid union. The sole indications for treatment presented by this class of cases are simply:

1st. That the wrist be supported in the prone position with the hand hanging loosely—thus maintaining the fragments in apposition.

2d. That movements of extension of the hand, for a time, be limited, lest separation of the fragments again be occasioned, and repair be interfered with.

With these simple precautions observed, the fracture becomes insignificant indeed, in comparison with the greater difficulties and dangers attending the sprain which it has accompanied. Fortunately the treatment of the fracture, as advocated, in no respect can interfere with the treatment demanded by the sprain.

The second class of cases—those in which noticeable displacement of the fragments exists—comprises the cases which have been recognized hitherto as especially difficult of treatment, to that extent even that the most accomplished surgeons have acknowledged their inability, in some cases, to prevent persistent deformity and lameness. The extract from the work of Hamilton, quoted at the beginning of this discussion, describes graphically the results hitherto attained. An analysis of the conditions remaining as the sequelæ of this injury, as there described, demonstrates that these sequelæ are of two kinds; first, bony deformity, the displaced fragments never having been reduced; and, second, ankylosis from effusion among and adhesion together of the peri-articular structures. An additional authority may be cited bearing upon this point. In the volume for 1865, St. Bartholomew's Hospital Reports, article on "Fractures interfering with the Movements at the Wrist," etc., by G. W. Callender, the author says, p. 288:

"We may, I believe, safely conclude that it is very often impossible to reduce the impaction of the proximal portion of the shaft, and that a certain amount of deformity is necessarily permanent."

Again, on page 292, he says:

"The stiffness, long continued, often permanent, which is so frequent and so troublesome a complication, follows from and is due to the damage—the bruising and tearing—which the adjacent tendons and muscles suffer at the time of the fracture, and which leads to their subsequent inflammation, with adhesion among themselves."

What is the damage to the usefulness of the limbs occasioned by the permanent bony deformity thus acknowledged as often inevitable?

Let Hamilton answer:*

"Any moderate, or even considerable, malposition of the lower fragment, after a fracture of the radius, is not sufficient, in itself, to occasion ankylosis. It is true that in the fracture now under consideration the direction of the articular surface of the radius is changed. But of what consequence is this, so long as the carpal bones, with which alone this bone is articulated, preserve their relations to the radius unchanged?"

The data is now before us from which to decide the question, hereto-

*Hamilton, op. cit., p. 279.

fore raised, which should have the preference in treatment in this injury—the sprain or the fracture?

The statements of authorities and the dictates of reason agree in these two points:

1st. The fracture entails no permanent disability.

2d. The sprain is the fruitful source of long-continued, sometimes permanent, impairment of the functions of the joint.

These facts being accepted, two conclusions are inevitable:

1st. The treatment of the sprain is first, both in order of time and of importance, in its demands upon the attention of the surgeon.

2d. No method of treatment of the fracture is justifiable which will interfere with the proper treatment of the sprain.

A full appreciation of the indications for treatment presented in this injury will demonstrate that no conflict exists between the measures demanded for the treatment of all the injured tissues.

The strained and lacerated soft tissues, and the fractured bone, alike demand that all the parts should be restored to their normal relative positions, as the first step of treatment. By the continued displacement of the bony fragments, repair of the soft tissues is interfered with, and danger of inflammatory complications increased.

The reduction of the fracture, however, has been confessedly difficult in many cases, and in some impossible. The theories adopted in explanation of this difficulty have been diverse. Muscular spasm and impaction have each had their partisans. Recently the theory that dislocation of the ulna and the binding down of its styloid process under the tense annular ligament, with the added pressure upon its head of the displaced tendon of the flexor carpi ulnaris muscle, constituted the impediment to reduction, has been advocated by Dr. E. M. Moore,* of this State.

Upon the views held as to the cause of the difficulty will depend the measures adopted for overcoming it. By the method of investigation which has been adopted in this paper, both muscular spasm and impaction have alike been eliminated from among the potent causes of the permanent deformity. A tense annular ligament, binding down a dislocated ulna with a displaced tendon riding over it, has been seen to be a mere optical illusion.

The demonstration has been clear that the chief agent in preventing the ready return of the displaced fragments to their proper coaptation, is the tense and unyielding untorn periosteal strip, which connects the fragments upon the dorsum.

* A luxation of the ulna not hitherto described, with a plan of reduction and mode of after-treatment, including the management of Colles' fracture. By E. M. Moore, M. D., etc.—Transac. Med. Soc. State of N. Y., 1870.

The failure to recognize this, and to direct the manipulations for reduction so as to meet the indications arising from it, has been the source of all the difficulties heretofore experienced in removing the deformity occasioned by severe cases of this injury. Granted that it is this which so persistently and firmly clasps the fragments together in a condition of pseudo-impaction, then this is the first obstacle to be overcome in securing reduction. It might be torn across by sufficiently powerful extension, and thus be overcome. There is a better and an easier way, however.

I take this wrist, which has been the subject of the experiment before you. It presents, strongly marked, the characteristic deformity, and illustrates the part played by the dorsal periosteal strip in question. (See diagram 5). By simply bending the hand and wrist backward, approximating the position in which the parts were when the displacement took place, the tense periosteum is relaxed. Slight extension now in the line of the forearm is sufficient to disentangle the rough surfaces of the fragments from each other. Moderate pressure upon the dorsum of the lower fragment causes it to fall into line. The weight of the hand is now sufficient to secure perfect apposition of the fragments; the periosteum again envelops closely the whole length of the radius; the tense inner fasciculus of the anterior ligament is completely relaxed; the radio-ulnar movements are free; the head of the ulna has ceased to project as if subluxated; all the parts have resumed their natural relations.

Dr. Moore, in the paper already referred to, describes a plan of reduction intended to meet the indications imagined by him to be present. His plan, circumduction of the hand with extension, has been proven practically to be of great value. To this I can testify from my own repeated experience. Upon analyzing it, the fact is patent that its value has rested in the fact that among the movements contemplated by it are included the movements which have just been shown to be the only ones necessary to effect reduction of this fracture, however great the displacement. All else in the plan of Dr. Moore is surplusage.

By the replacement of the fragments of the radius in their normal relations, the fracture has become one of the first class—with this difference simply, that the sprain of the soft parts is much more aggravated.

All the measures indicated as of value in overcoming the results of sprained wrist, elaborated and described in the first part of this treatise, are now of importance in the further treatment of this injury. Compression and support, by means of a bandage encircling the joint, is of value. The snug application of a strip of strong adhesive plaster, two inches wide, so as to grasp firmly the lower extremities of both radius and ulna, will restrict effusion, reinforce the radio-ulnar ligaments, and render more tolerable efforts at motion of the wrist-joint.

Massage, early, persistently and skillfully applied, is of the greatest importance in the after-treatment. The conditions are such as to warrant the statement that its most brilliant results are to be achieved in the treatment of this injury.

Motion, early, regular and decided in character, is of great importance. Use of the hand should be encouraged after the third day.

Is any further apparatus necessary for the support and retention of the radial fragments in place? The line of fracture is transverse; the fractured surfaces are broad; when brought into coaptation their irregularities fit into each other; upon the inside the ulna affords support; upon the back the extensor tendons, made somewhat tense by the drooping hand, are to be added to the weight of the hand as agents in preventing displacement backward.

The untorn dorsal periosteum prevents any forward displacement, if any tendency to it exists. Upon the outside, the adhesive strap, firmly applied, prevents displacement in that direction, while it reinforces the power of all the other forces enumerated, as it encircles the whole wrist.

What indication is unfulfilled? The sprain and the fracture, alike, are perfectly cared for.

The second general conclusion as to treatment, that no method is justifiable which will interfere with the proper treatment of the sprain, must not be lost sight of.

This conclusion is a perpetual indictment against the use of all and any splints in the treatment of this injury.

They meet no indication. If they are short, they do nothing. If they are long, they do positive injury. The multitudinous forms and combinations of splints which have been contrived have all been the result of mistakes as to the real pathology of the injury, and are all alike useless, varying only in the degree of their harmfulness. Whatever good results have been obtained in cases splinted have been in spite of treatment, and not in consequence of it.

Throughout I have refrained from encumbering my argument by details of particular cases as illustrations. I have endeavored to make this a rational discussion of the points involved in the pathology and treatment of this injury. Clinical experience, however, is not wanting with which to corroborate or to combat the conclusions of reason.

During the past six years, 49 cases of Colles' fracture have presented themselves to me for treatment, and also 40 cases of severe sprain of the wrist, in which fracture of the radius was not made out, although in many of them I am persuaded that it existed.

In addition to these, I have been privileged to watch many more cases under the treatment of other surgeons. Among the cases thus enumerated, both sexes and all ages, from childhood to advanced old age,

have been represented; every degree of severity of injury to the parts has been witnessed, from a simple fracture, with the slightest possible amount of displacement and of injury to the surrounding soft parts, to a compound fracture, with great displacement of the fragments and marked luxation of the ulna. Divers kinds of appliances have been used in the treatment of these cases; but in no instance of wrist-joint injury, treated by myself, was a splint applied.

The careful observation of these cases has made it possible for me to put to the test any theoretical vagaries entertained.

To sum it all up, this experience has accorded perfectly with the doctrines now advocated; wherefore I confidently claim that my conclusions are not mere theoretical vagaries, but that, founded in reason and established by clinical proofs, they are safe guides for surgical practice.

Fracture of the radius near the wrist-joint, with dislocation of the ulna, more or less complete.

Subluxation of the ulna is usually present in the second class of fractures of the radius near the wrist-joint.

The reduction of the fracture determines, without other manipulation, the restoration of the ulna to its normal relations.

In rare instances, with extreme displacement of the radial fragments, the radio-ulnar ligaments are torn across, and the ulna, completely dislocated, is thrust downward and forward upon the pisiform bone.

In such cases, no less than in those of mere subluxation, the reduction of the fracture accomplishes the reduction of the dislocation.

This follows from the fact that it is the radial fragment which is dislocated from the ulna and carried upward—not the ulna which is torn from the radius. When the radial fragment is brought down again to its proper place, it and the carpus attached to it must resume their proper relations to the ulna.

The presence of these conditions will require no material modification of the method of treatment which has been developed in the discussion of the fracture. They are simple exaggerations of the condition of sprain, and intensify the indications for treatment arising therefrom.

The action of the encircling adhesive strap in keeping the ulna up to its proper place, will be assisted by a compress, applied along the inner border of the ulna, enclosed by the strap. The wearing of a narrow sling, in which the wrist is supported upon its ulnar side, while the hand hangs freely, brings to bear the weight of the hand as an agent in preventing separation of the articular surfaces.

These devices are recommended by Dr. Moore, and are both rational and efficacious.

Fracture of the radius and ulna near the wrist-joint.

The feature which this injury may possess, in common with the injur-

ies already discussed, is sprain suffered by the tissues about the wrist-joint. The extent to which this may be present will depend upon the manner in which the injury has been sustained ; this cannot be reduced to definite and certain laws, as in the preceding instances.

Although in this injury the necessity of the support of a splint in its treatment exists, the possible condition of the wrist structures must be ever kept in view, and the most assiduous care be given to it, according to the principles hitherto elaborated.

CONCLUSION.

The following résumé briefly states the most important conclusions arrived at, as the result of this re-examination from a rational stand-point of the more common injuries to the wrist-joint.

1st. Motion, massage, support and compression are of chief importance in the treatment of sprains of the wrist-joint.

2d. Immobilization, prolonged beyond the period of afflux, increases the dangers of inflammatory complications, and prolongs the period of repair.

3d. Severe sprain of the wrist is liable to be complicated by a transverse fissure of the radius near its lower extremity. This injury cannot be positively demonstrated in any given case, and does not call for special treatment.

4th. Transverse fracture of the radius within one inch of its lower extremity, is the result of a force of avulsion communicated to it through the medium of the anterior ligament of the wrist-joint, as the consequence of extreme bending backward of the hand and wrist.

5th. Displacement of the fragments is the result of a downward and forward impetus impressed upon the upper fragment of the radius, still in action after the avulsive force has become expended.

6th. By the displacement, the posterior aponeuro-periosteal envelope of the radius is not torn across, but is stripped up from the back of the upper fragment for a variable distance, retaining its attachments to the lower fragment also.

7th. The state of flexion into which the hand is thrown, upon its recovery from the position of extreme extension, renders this dorsal strip tense, and causes the lower fragment to become entangled by the projecting rough posterior border of the upper fragment.

8th. The strength and tension of this dorsal pseudo-ligament may be such as to resist powerful extension in the line of the long axis of the radius, and to occasion great difficulty in the reduction of the fracture. It is the chief agent in the production of permanent bony deformity as a sequel to this injury.

9th. The movement of rotation backwards around the head of the ulna performed by the lower fragment and the attached carpus and hand, simultaneously with the displacement of the radial fragments, is due chiefly to the oblique direction and point of ulnar attachment of the strong inner fasciculus of the anterior ligament of the wrist.

10th. Reduction of the fracture, even in cases of extreme displacement, is easily effected by bending the hand and wrist sufficiently far back as to relax the dorsal pseudo-ligament; slight extension and manipulation will then suffice to restore the fragments to their proper relations.

11th. The fracture is both preceded and followed by a severe sprain. The sum of the injuries inflicted presents a sprain of the most aggravated description.

12th. The fracture never entails permanent disability.

13th. The sprain is the fruitful source of long-continued, sometimes permanent, impairment of the function of the joint.

14th. The sprain is first, both in order of time and of importance, in its demands upon the attention of the surgeon.

15th. After the reduction of the fracture, every support necessary for its satisfactory retention is afforded by the structures which surround it, with the simple addition of an adhesive strap snugly encircling the wrist so as to firmly grasp the injured structures.

16th. No splint of any kind is useful in the treatment of this fracture.

If applied so as to exert any control over the fragments, they cannot in any form retain the fragments in coaptation more perfectly than can be accomplished without them, while they interfere much with the proper treatment of the sprain.

17th. Dislocation of the ulna, more or less complete, does not alter the indications for treatment, nor demand any material modification of the methods to be used.

18th. These conclusions, based upon experiment and reason, have now been established by sufficient clinical experience to remove them from the domain of mere theories; although widely departing from the teachings of surgical tradition, they claim acceptance as safe guides in practice.

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